Mission Operations Working Group Report

EOS Aura Science Team Meeting
October 3, 2007

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Earth Science Mission Operations Project/428

Topics

- **Aura to Aqua Re-phasing**
- Spacecraft & Instrument Status
  - S/C Subsystems
  - Recent Activities
  - Anomalies
  - Data Losses
- Planned Activities
- Summary

MOWG MEETING ATTENDEES

Aura Project: Mark Schoeberl

HIRDLS: John Barnett, John Gille, Chris Hepplewhite, Jim Craft, Joanne Loh, Vince Dean, Craig Hartsough

MLS: Dominick Miller, Dong Wu

OMI: Pieternel Levelt, Jacques Claas, Osmo Aulamo, Phillip Durbin

TES: Doug Shepard, Robert Murdock, Rob Toaz

GSFC ESDIS: Alfreda Hall

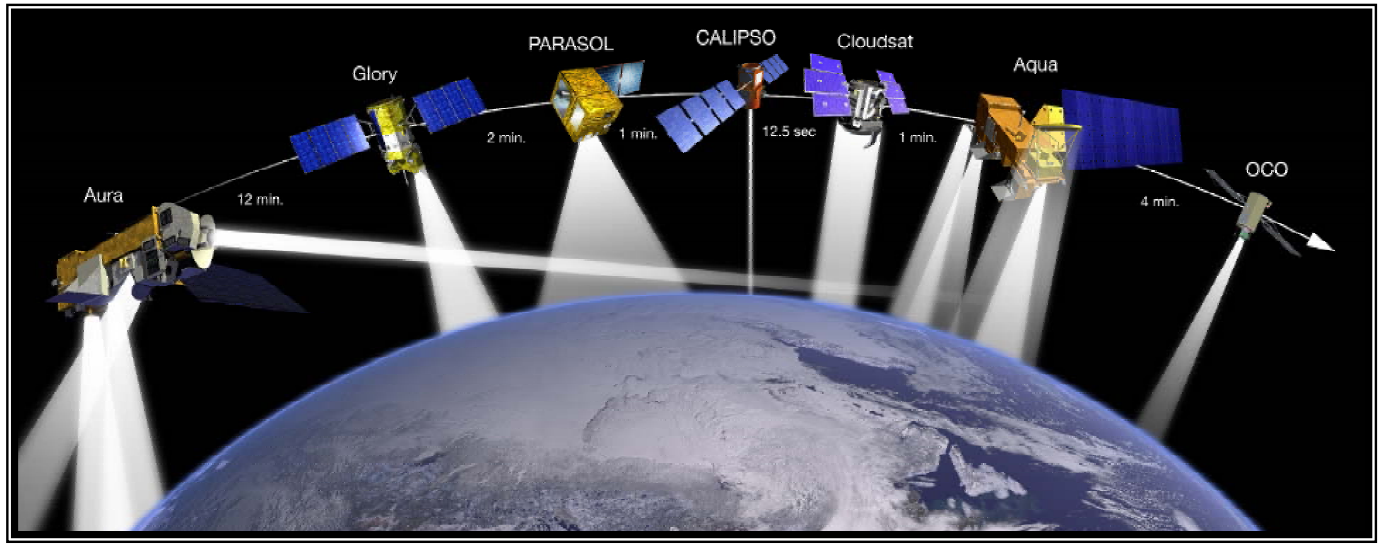
GSFC ESMO: Pat Johnson, Dimitrios Mantziaras, Joe Purcell, David Tracewell, Bill Guit, Angie Kelly

REVISED AGENDA

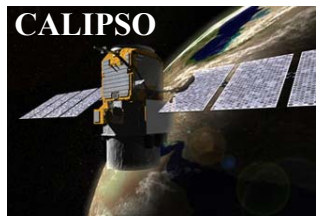
8:30	Greetings/Introduction/Agenda Review	All
8:35	**Aura Relocation (Re-phasing): FD Approach and Discussion**	**Brian Robinson/All**
9:15	EOS Aura Status	A. Kelly/B. Guit
9:30	HIRDLS	C. Hepplewhite, J. Craft, J. Barnett, T. Walton, J. Gille
9:45	MLS	D. Miller/D. Cuddy
10:00	OMIS	J. Claas
10:15	OMI DB in Sodankyla	O. Aulamo
10:30	BREAK	
10:45	TES	R. Murdock
11:00	SSR Auto Operations Concept	D. Mantziaras
11:50	Ground System Re-engineering Plans & Schedule	P. Johnson
12:10	Updates to Ops Agreements (afternoon splinters)	J. Purcell
12:20	Summary/Actions/Next Steps	All
12:30	LUNCH BREAK	

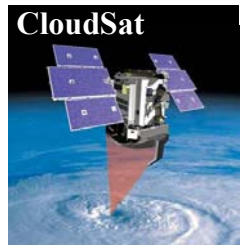
Aura to Aqua Re-phasing

Earth Science Afternoon Constellation (A-Train)



- **CloudSat and CALIPSO** launched April 28, 2006 and joined the Afternoon Constellation on May 31. There are now 5 satellites in the "A-Train".
- **OCO** mission is progressing – launch in late 2008
- **Glory** is planning to join the Constellation at ~ 4 minutes behind Aqua
- **Evaluating plan to move Aura about 7 minutes closer to Aqua**





Mission	MLT
Aqua	01:34:43
CloudSat	01:43:25
CALIPSO	01:43:37
PARASOL	01:33:14
Aura	01:43:39

As of September 17, 2007

Aura to Aqua Re-phasing

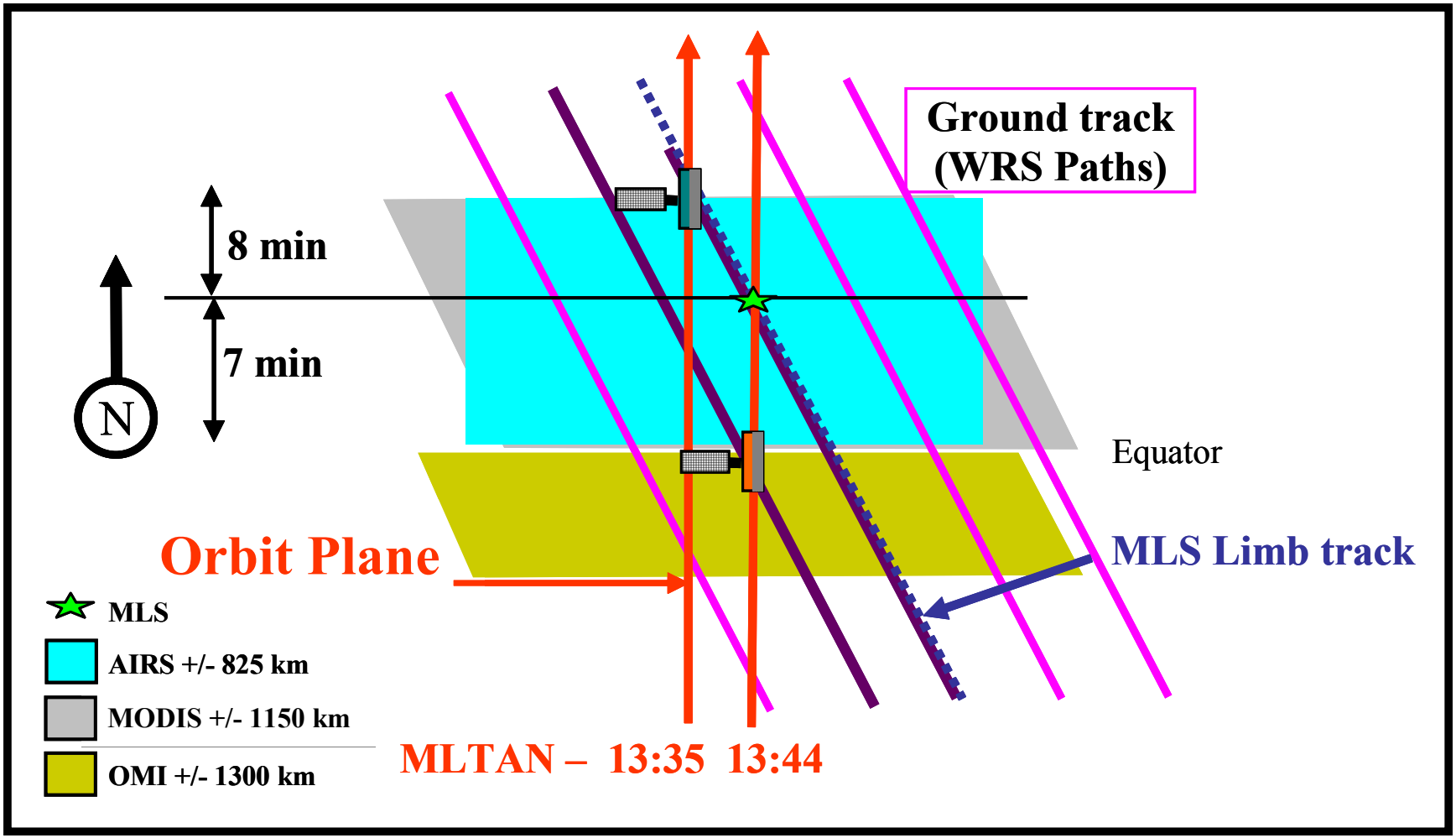
- M. Schoeberl requested an analysis in early 2007
  - •• **Move Aura closer to Aqua by ~ 7 minutes**
  - – Phase change would decrease the amount of time between Aqua and Aura instrument measurements.
  - •• **To obtain better science utilizing A-Train data**
- Preliminary analysis was discussed with M. Schoeberl in June and sent to Aura teams in June/July
- OMI operations team provided comments/concerns; discussed at telecon on 9/13/07
- EOS Flight Dynamics presented updated plan/options at Aura MOWG meeting on Oct 2

Aura Re-Phasing Impacts

- **SAFETY:**
  - Moving Aura closer to Aqua (~7 minutes) can be implemented safely
  - No safety concerns with other A-Train satellites
- **Mission Life:**
  - Moving Aura closer to Aqua involves a small amount of fuel, thus, no impact to Aura's mission life

    -- Currently holding adequate fuel reserve to meet 25-year re-entry guidelines

Current Phasing

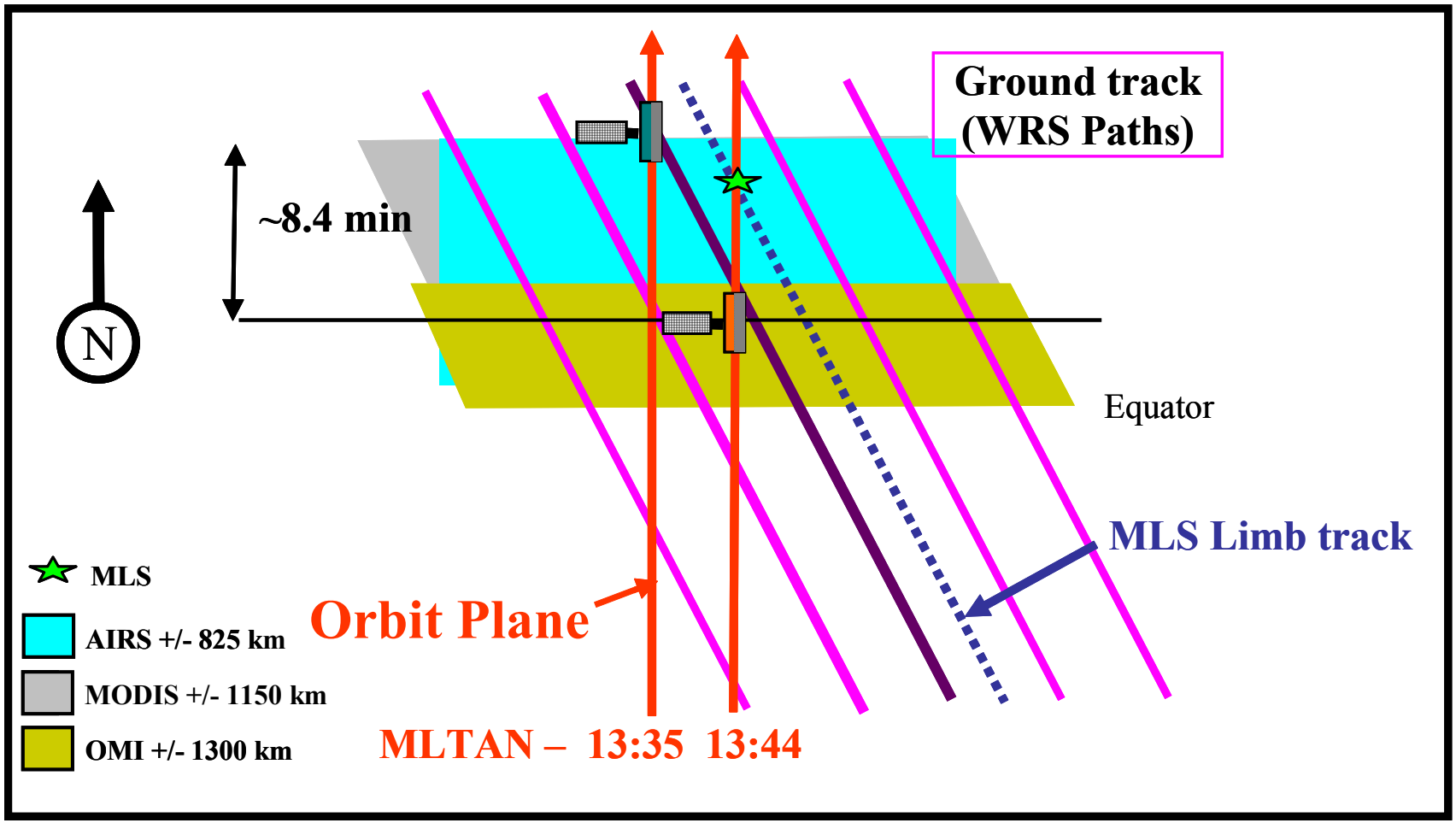


Current phasing is ~16 minutes in along-track separation, trending towards a minimum of ~15 in the next two years.

Current Aura Orbit Requirements

- Maintain MLTAN between 13:30 and 14:00
  - Due to current MLTAN phasing with Aqua and timing of inclination maneuvers, MLTAN has been maintained between 13:40 and 13:45.
  - Current MLTAN is 13:44 and is trending to a minimum of ~13:42.
- Orbit +/- 20Km of the WRS-2 ground path that is 1 path + 25 Km West of Aqua at the descending node.
- Phasing of 15-22 minutes in along-track separation, but as close to 15 minutes as possible
  - Current phasing is ~16 minutes in along-track separation, trending towards a minimum of ~15 in the next two years.
- Solar beta angle requirement is 16 – 36 degrees.
    - OMI Request: Maintain a solar beta angle of 18.3 to 31.2 degrees (9/13/07).

Proposed Phasing



Implementation Options

- **Option I – Drag Option**
  - Use atmospheric drag to reduce Semi Major Axis (SMA) and drift closer to Aqua.

- **Option II – Inclination Maneuver Option**
  - Use 2 inclination maneuvers to reduce SMA and drift closer to Aqua.

Pros/Cons

	I – Drag Option (preferred option)	II – Inclination Maneuver
Drag Environment Dependency	3	1
Drift Duration	2	1
Analysis Required	1	1
Fuel Usage	1	1
MLTAN Profile	1	1
MLTAN Separation Drift Rate	1	1
Timeliness (Start Time)	1	3
Completion Date	1 (start date + 6-9 months)	3 Spring 2009

1 – Best, 2 – Medium, 3 – Worst

FEEDBACK FROM THE AURA INSTRUMENT TEAMS

Instrument	Agree to Re-phasing?	Comments
HIRDLS	Yes	
MLS	Yes	7.7 minutes is ideal for coincidental science with CloudSat (Dong Wu).
OMI	TBD	KNMI to determine flight software impact. Answer due Oct 17, 2007
TES	Yes	

SUMMARY

- **Aura re-phasing can be accomplished safely**
- **Aura re-phasing will not impact mission life**
- **Drag option is preferred implementation**
  - Does not require new procedures;
  - Can be completed by Spring 2008 (based on December 2007 start date)
- **Decision is needed by Dec 5 (next Drag Make-up maneuver)**
- **Aura re-phasing will result in better science!**

SPACECRAFT STATUS

Spacecraft Subsystems

- **Command & Data Handling (CDH)** – Nominal
  - Solid State Recorder (SSR) – holds 3 orbits of data
- **Communications (COMM)** - Nominal
- **Electrical Power System (EPS)** – Nominal
  - *Solar Panel Connector Anomaly (January 12, 2005)*
- **Flight Software (FSW)** - Nominal
- **Guidance, Navigation & Control (GN&C)** - Nominal
- **Propulsion (PROP)** – Nominal
  - *Dual Thruster Module (DTM-3) Anomaly (August 16, 2005)*
- **Thermal Control System (TCS)** – Nominal

All subsystems configured to primary hardware

Recent Activities (since August 2006)

Major Activities

- 08/16/06: – NASA HQ Review
- Aug-Sep: Inclination Adjust
- Mar-May: Inclination Adjust
- 06/12/07: Flight Ops Status Review
- 07/15/07: 3-Year Anniversary
- July-Aug: TC4 Campaign
- 07/30/07: MLS Venus Scans
- 10/02/07: MOWG (at Science Team Meeting)


NASA


AFTERNOON CONSTELLATION
A-Train
EOS AURA
Chemistry & Climate

Anomalies

Anomalies

- Spacecraft Anomalies
  - No new anomalies
- Instrument Anomalies
  - 10/10/06: HIRDLS Gyro 0 Anomaly
  - 04/28/07 HIRDLS Gyro 3 Anomaly
  - 07/14/07: MLS SIF4 Anomaly
  - 08/04/07: TES Filter Wheel Anomaly
  - 08/07/07: MLS Mechanism Anomaly


NASA


AFTERNOON CONSTELLATION
A-Train
EOS AURA
Chemistry & Climate

Data Losses

Data Losses

- No SSR Science Data lost since July 2006

Planned Activities

Planned Activities

- Aura Re-location – Timing is TBD
- HIRDLS Pitch Maneuver – Nov 6th
- SSR Auto Ops with EDOS fix (2008)
- Spring 2009 Inclination Adjust
- Aura Senior Review in 2009

Summary

- Spacecraft Status – GREEN
- Instrument Status – GREEN
  - Operations Nominal
- Data Capture – GREEN
  - **SSR Data Capture ~ 99.989 %**
- Planned Activities:
  - Drag Make-up Maneuver – Dec 5 ?
  - HIRDLS Pitch – Nov 6, 2007

Questions?

Thank you!

ADDITIONAL INFORMATION

Option I – Drag Option

- Use atmospheric drag to reduce the SMA and initiate the forward drift.
  - Stop performing Drag Make-Up (DMU) maneuvers until desired separation is attained
- Once the correct phasing is reached an orbit raising maneuver would stop the drift and establish a new ground-track control box.
- NO change to the current MLTAN profile.

Note: Next DMU is ~ Dec 5

Option I – Drag Option Evaluation

	Case	Days to Re-phasing	Decrease in SMA, meters	Estimated DMU Burn Duration to Establish New Ground Track, sec	Estimated Total Fuel Usage, Kg
Pre-DMU	Option 1, Case 1: HP65 Atmosphere	192	170	22	0.13
	Option 1, Case 2: HP75 Atmosphere	175	195	23	0.13
	Option 1, Case 3: HP100 Atmosphere	136	300	37	0.24
	Option 1, Case 4: HP125 Atmosphere	105	450	57	0.35
Post-DMU	Option 1, Case 5: HP65 Atmosphere	279	230	30	0.19
	Option 1, Case 6: HP75 Atmosphere	252	280	35	0.22
	Option 1, Case 7: HP100 Atmosphere	179	370	45	0.27
	Option 1, Case 8: HP125 Atmosphere	125	515	65	0.41

The duration of the re-phasing will be dictated by Aura's position within the ground-track cycle. Pre- and Post-DMU results are reported to indicate the additional time required to drift through the ground-track cycles of each drag environment.

Option II – Inclination Maneuver Option

- Execute inclination maneuver that would lower the orbit in order to initiate a drift forward.
  - DMUs would be halted until desired separation is attained.
  - Once the correct phasing is reached an orbit raising maneuver would stop the drift and establish a new ground-track control box.
  - A small change to the MLTAN would be incurred due to the use of inclination maneuvers
  - The MLTAN is not expected to drift below 13:40

Option II – Inclination Maneuver Option Evaluation

Case	Days to Re-Phasing	Decrease in SMA, meters	Estimated DMU Burn Duration to Establish New Ground Track, sec	Estimated Total Fuel Usage, Kg
Option 2a, Case 1: -85 yaw	40/Spring '09	420	50**	5.5
Option 2b, Case 1: -85 yaw	59	500	60**	0.4

** Burn duration for Ground Track control only; does not include any needed inclination maneuvers.